ON THE

EFFECTS OF LESION

OF THE

TRUNK OF THE GANGLIONIC SYSTEM OF NERVES IN THE NECK UPON THE EYE-BALL AND ITS APPENDAGES.

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In a former communication in this Journal (for January 1838, p. 132,) I stated that I had frequently verified the observations of Petit and others, that when the *vagus* is injured in the neck in those animals in which the sympathetic is combined with the *vagus*, as in the dog,—that the *conjunctiva* becomes inflamed, the pupil contracts, and the eyelids are somewhat more closely approximated to each other. At that time I suggested that the contracted pupil and partially closed eyelids might probably depend upon the impatience of light which sometimes accompanies inflammation of the *conjunctiva*. I have since attended more carefully to this subject, and during the last summer satisfied myself that the contraction of the pupil, the projection of the cartilaginous membrane, or third eyelid, situated at the inner angle of the eye over the cornea, and the partial approximation of the eyelids to each other, take place immediately after the injury of the sympathetic, and before the inflammation of the *conjunctiva* presents itself, and that they continue after it has disappeared. I shall here detail a few of the experiments which I have made in elucidation of this point.

Exp. I. The *nervus vagus* and sympathetic were cut on the

left side in a small terrier, and instantly the pupil of the eye became considerably diminished in size, and the cartilaginous membrane at the inner angle of the eye was forced over the internal margin of the *cornea*. A quarter of an hour after the division of the nerves, the *conjunctiva* of the left eye appeared more vascular than that of the right, and the *cornea* was perhaps a little dimmer. There was also some increased secretion of tears from the left eye, and the condition of the pupil and third eyelid remained as before.—Twenty-four hours. The *conjunctiva* of left eye was vascular and covered with a thick tenacious mucus, and the appearance of the *iris* and the third eyelid was the same as immediately after the division of the nerves. Some slight vascularity of *conjunctiva* of right eye, and some increased secretion of mucus, but there was no apparent change upon the pupil and third eyelid.—Third day. The *cornea* of left eye was dim, and the *conjunctiva* very vascular, and covered with much tenacious mucus. The *conjunctiva* of right eye was somewhat vascular, and covered with a small quantity of mucus.—Seventh day. The *cornea* of left eye was less dim, and there was less inflammation of *conjunctiva*, but it was still covered by a considerable quantity of puriform mucus. The pupil was still contracted, and the cartilaginous membrane projected over the *cornea*. The animal was now made the subject of another experiment. In this and in several other experiments which I have made, with a similar view, I was assisted by my friend Dr Staberoh of Berlin.

Exp. II. The *vagus* and sympathetic were cut across on one side, and a portion removed in a middle-sized cocker dog, after the exact similarity of the two eyes had been ascertained. Immediately after the section of the nerves, the pupil became contracted, the third eyelid projected over the inner edge of the *cornea*, the eyeball was apparently placed deeper in the socket, and rolled inwards, and the eyelids partially closed. At this time there was no perceptible redness of the *conjunctiva*. Ten minutes after the section of the nerves the pupil and eyelids remained in the same state, and there was no vascularity of the *conjunctiva*.—Twenty-four hours. The *conjunctiva* of the side operated upon was very vascular with increased secretion of tears; the *cornea* was, however, clear, and there was no inflammation observable in the deeper parts of the eyeball. The opposite eye had undergone no change from the natural condition.—Forty-eight hours. No perceptible change since yesterday.—Fifth day. Rather less vascularity of the *conjunctiva* of the side operated upon, and it was partially covered with some puriform mucus. The other appearances remained as before.—Sixth day. Less vascularity of *conjunctiva*, no other perceptible change.—Eighth day. Vascularity of *conjunctiva* nearly gone, the pupil is apparently less contracted, and the third eye-

id projects decidedly less over the *cornea*.—Tenth day. There are still some remains of conjunctival inflammation. The pupil is still very perceptibly smaller than that of the sound eye; the cartilaginous membrane projects less over the *cornea*, and the eyelids are less approximated, though evidently closer to each other than in the sound eye.—Third week. Scarcely any traces of redness on the *conjunctiva;* the third eyelid still projects forwards, but it does not now encroach on the *cornea;* other appearances remain as before.—Five weeks. Redness of *conjunctiva* entirely gone, but other appearances remain unchanged.—Two months. The pupil of the eye of the side operated on is still very decidedly less than that of the opposite side, and the eyelids are evidently somewhat more approximated. The pupil was not, however, motionless, but it has continued to contract and dilate when exposed to a stronger or feebler light. The animal was now killed by a dose of prussic acid, and it was observed that while expiring, the pupils of both eyes were much dilated and became of equal size.

Exp. III. The left superior cervical ganglion of the sympathetic was removed in a dog in which the common carotid of that side had been previously secured to prevent hemorrhage. Great care was taken to avoid injury of the *nervus vagus*. The lower half of the ganglion was at first only removed, and this was immediately followed by contraction of the pupil, the projection of the third eyelid over the inner edge of the *cornea*, and the other appearances remarked in the previous experiment. One minute after this the whole of ganglion was removed without any apparent increase of the effects previously produced.—Twenty-four hours. Scarcely any increased redness of left *conjunctiva*, but there is some slight increased secretion of mucus. Pupil as yesterday. The eye remained nearly in the same state during the fortnight it was allowed to live. It ate freely, was quite active, and never showed any tendency to stupor.

In the dog, as I have already remarked, it is impossible to cut the *nervus vagus* in the middle of the neck without also dividing the trunk of the sympathetic. In the cat, however, though these two nerves lie in the same sheath, yet by a little care they can be easily separated from each other opposite the thyroid cartilage; and in the rabbit they have nearly the same relation to each other as in the human species. The cat and the rabbit consequently furnish an opportunity of experimenting upon these nerves singly.

Exp. IV. The sheath of the right carotid was exposed high in the neck in a kitten, and the sympathetic was then cautiously separated from the *vagus* without injuring the latter. When the sympathetic was compressed with a moderate force, the right pupil began to contract gradually, and became much smaller than that of the left eye; and it again resumed its former size on re-

moving the pressure.* A portion of the right sympathetic was now removed, and the pupil again contracted slowly, and remained permanently smaller than that of the left eye; the cartilaginous membrane was pushed considerably over the anterior surface of the cornea, and the eyelids were partially approximated to each other.—Twenty-four hours. No distinct redness of *conjunctiva*. Condition of right eye the same as yesterday, and the pupil, though constantly smaller than the left, contracts and dilates within certain limits on exposure to a stronger or feebler light. The animal was lively. It died seven days after the division of the nerve. At the time of its death no distinct redness of the *conjunctiva* had presented itself, and the eye had the same appearance as the day after the operation.

Exp. V. The left sympathetic was cautiously separated from the *vagus* in the neck of a full-grown cat, and cut across. The iris immediately contracted slowly, and gradually, and soon presented a marked contrast to the right pupil, and the third eyelid was pushed over the inner surface of the *cornea*. The right *vagus* was now exposed, separated from the sympathetic, and divided without injuring the latter. This was followed by no change upon the right eye. The right sympathetic was now divided, and the same phenomena presented themselves as in the left eye. Dr Alison was present at this experiment. No distinct redness afterwards presented itself in the *conjunctiva* of either eye. When the animal was killed three weeks after division of the nerves, the cartilaginous membranes at the inner angles of the eye, though more distinctly visible than usual, did not project over the *cornea;* the pupils were exactly similar, and appeared to have nearly recovered their usual size. As in this experiment, however, both sympathetics had been cut, we could not judge of the effects of the operation upon the pupil as in the cases where the sympathetic was divided on one side only, for then the sound eye served as a standard of comparison.

Exp. VI. I removed a portion of the right sympathetic from the neck of a full-grown cat in the presence of Dr Monro and Mr Mackenzie. On cutting the nerve across, the pupil was instantly seen to contract slowly and gradually, and soon presented a marked contrast with that of the opposite side. The cartilaginous membrane at the same time gradually encroached upon the surface of the inner part of the *cornea*, the eyeball appeared deeper, and the eyelids more approximated than those of the opposite eye. A month after section of the nerve, the size of the pupil still presented a very striking difference from that of the left eye; and the

* This experiment of producing contraction of the pupil by compressing the trunk of the sympathetic in the neck, I have repeated with success in other cases not detailed here.

cartilaginous membrane projected more than that of the opposite side, though it no longer encroached upon the *cornea*. The animal never lost its activity. *

Exp. VII. In one rabbit the trunk of the sympathetic was first divided on one side of the neck, and a portion removed ; and a few days after, the same operation was repeated on the opposite side. In other seven rabbits the superior ganglion of the sympathetic or a large portion of the trunk of the nerve was removed on one side without tying or injuring any of the large blood-vessels or any other nerve, and in two of these the same operation was repeated on the opposite side. In one of these only was there any change observed upon the iris, and no decided increased redness of the *conjunctiva* presented itself. In one of these animals it was remarked that the eyelids of the side on which the superior ganglion of the sympathetic had been removed, was less apart than on the opposite eye ; but whether this was the effect of the removal of the ganglion, or of some slight injury received during the operation, we cannot at present pretend to determine. From these experiments it would appear that in rabbits the superior ganglion of the sympathetic, and a considerable portion of the trunk of that nerve as it lies in the neck, may be generally removed without effecting any change upon the iris ; while the compression or section of the trunk of the sympathetic in the neck in dogs and cats is instantly followed by contraction of the pupil, the forcing of the cartilaginous membrane over the inner part of the anterior surface of the eyeball, the retraction of the eyeball deeper into the socket, and a slight approximation of the eyelids. In dogs this also is followed,—sometimes after a very few minutes, but generally after a longer interval,—by inflammation of the *conjunctiva*, which is occasionally so severe that this membrane presents an almost uniform redness, and is covered by puriform mucus, and the cornea becomes dim. As far as I have been able to observe this, inflammation is confined to the *conjunctiva*. To judge from the limited number of experiments which I have yet made upon cats and rabbits, the inflammation of the *conjunctiva* in the former is trifling, if present at all ; and in the latter it is entirely absent. I was at first inclined to believe that the outward projection of the third eyelid, for in the dog and cat it has no muscles attached to it, was dependent upon the rolling inwards of the eyeball ; but subsequent observations have nearly satisfied me that this depends upon the *retrahens oculi* muscle drawing the eyeball deeper into the orbit, by which the fat is pressed forwards, and the third eyelid pushed over the anterior surface of the eyeball. This would

* In a cat on which I assisted Mr Little to repeat this experiment, the pupil was nearly natural a month after a portion of the sympathetic and *par vagum* on one side were removed.

also explain the approximation of the eyelids. I find it impossible at present to give any thing like a plausible explanation of the effects of injury of the sympathetic upon the eyeball and its appendages, and the cause of their dissimilarity in different animals. It is evident, however, that this is to be sought for in the connection of the branches of the sympathetic with the encephalic nerves of the orbit, and especially with the sixth pair, and those branches forming the ciliary nerves. I intend at my earliest opportunity to endeavour, by extensive minute dissections of the ascending branches of the superior sympathetic ganglion in various Mammalia, to give some probable solution of this question. We may then be able to judge whether an injury of the cervical portion of the sympathetic in man, such as may possibly occur in certain diseases and operations on the neck, would be followed by contractions of the iris and inflammation of the *conjunctiva*. In a case described in the Medical Gazette,* where the right carotid, the vagus and surrounding parts are described as being enveloped in a large morbid tumour, and where, consequently, the sympathetic could hardly be supposed to escape, the pupil of that side is described as becoming smaller during the course of the disease.

This contracted state of the pupil, consequent upon lesion of the sympathetic in the neck, is not noticed in the experiments of Cruickshank, † Arnemann, ‡ Mayer of Bonn, § and Brachet, ‖ though all these authors describe its effects upon the *conjunctiva*. Indeed, Arnemann expressly states, "that he has not observed the changes upon the pupil which Molinelli has remarked after ligature of the eighth nerve"¶; and Brachet, in relating his first experiment, where the trunk of the sympathetic was divided in the neck of the dog for the purpose of observing its effects on the eye, makes the following observation;—"L'iris n'en a reçu aucune influence marquée; il a continué de se contracter suivant la vivacité de la lumière: cette remarque ayant été commune à toutes les experiences, je ne la reproduirai pas." Petit** remarked this contraction of the pupil in some of his experiments; but his observations would lead us to believe that it was a subsequent and not an immediate effect, and could not enable us to decide whether or not

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* September 29, 1838, p. 16.

† Medical Facts and Observations, Vol. vii. p. 136, or Phil. Trans, 1795, Part I.

‡ Versuche über die Regeneration der Nerven, S. 69, 85–6–7–9, 94–6–7–9, 102. Göltingen, 1787.

§ Journal der Chirurgie von Gräefe und Walther, Zehnter Band, S. 418.

‖ Recherches Experimentales sur les Fonction du Systeme Nerveux Ganglionaire, Chap. ix. Experiment 150–1–2, &c.

¶ Oper. cit. s. 96.

** Memoire dans lequel il est demontré que les Nerfs Intercostaux fournissent des rameaux qui portent les esprits dans les yeux. Histoire de l'Academie Royale, 1727.

it was dependent upon the inflammation of the *conjunctiva*. In Experiment I. of the second series of his two sets of experiments,* the right vagus was cut on the 18th September; and on the 19th, he remarked, among other changes on the eye of that side, that the pupil was less. The left vagus of the same animal was afterwards divided, (Experiment II. p. 11,) and in a quarter of an hour he observed the cornea flattened, and the pupil contracted. In Experiment III. and IV. he observed the pupil to be contracted one hour after section of the nerves. In Experiment V. he made this curious observation, that when the nerves were cut on both sides, dilatation of the pupil followed, and more in the right eye than in the left. This animal, it is worthy of remark, suffered much from dyspnœa, and died in twelve hours. In the numerous experiments which I have made upon the effects of section of the vagi, I never observed any thing similar to this; on the contrary, the pupils always became contracted.

Molinelli† relates five experiments upon dogs, in which he watched the effects of ligature of the vagus and sympathetic upon the eye. In one experiment he informs us, (p. 281,) that a little after the left vagus was tied, the *conjunctiva* of the left eye became red, and the cartilaginous membrane at the inner angle of the eye projected over the cornea. On the seventeenth day after the operation, he observed that the pupil of that eye was diminished in size. In Experiment III. (284) the left vagus was tied with a double ligature on the 14th January; and on the 30th it was remarked that the pupil of the left eye was twice as small as the right, and that the eyeball seemed depressed. In Experiment IV. he mentions a change of colour in the iris; but there is nothing said about the diminution of the pupil. Dupuy‡ in two of his experiments mentions this contraction of the pupil. In one experiment (Oper. cit. Premier Fait, p. 343,) he remarked that the pupil became contracted immediately after the superior ganglion of the sympathetic had been extirpated. His words are these,—"Aussitôt après l'operation, l'œil de ce côté parut plus enfoncé dans l'orbite, les paupières étaient tumifiées, la membrane clignotante se portait en avant du globe oculaire la pupille se resserra." In a subsequent experiment, (Troisième Fait, p. 347,) the operation was performed on the 26th April; and on the 10th May he observed that the pupil was contracted. Though I have occasionally observed very severe inflammation of the *conjunctiva* follow this operation in dogs, yet I have never seen it proceed to the disorganization of the eyeball. In one of Arnemann's experiments it appears to have produced ulceration of the cornea.§ In two of Mayer's

* Oper. cit. p. 10.
† Comment. Bononiensi, Tom. iii. 1755, p. 280.
‡ Journal de Médecine, Chirurgie, &c. December 1816, Tome xxxvii. p. 340.
§ Oper. cit. Acht und Sechzigster Versuch, S. 69.

experiments upon rabbits, where the vagus and sympathetic were not only enclosed in ligatures, but the common carotid was also tied, inflammation of the cornea occurred, and this in one case was followed by ulceration, and in the other by staphyloma, and the effusion of a layer of lymph upon the anterior surface of the iris, obliterating the pupil.* Brachet relates several experiments to show that injury of the sympathetic or destruction of its superior cervical ganglion is attended by great vascular congestion of the anterior and middle lobes of the brain, producing drowsiness and stupor.† The experiments which I have made on this point do not by any means confirm those of M. Brachet.‡ As the fact, if correct, is one of great importance, and ought to be very carefully investigated, I shall reserve the consideration of this and some of the other questions connected with the lesion of the cervical portion of the sympathetic, and more especially the length of time the contracted state of the iris continues after a portion of the nerve has been removed, until a future opportunity.

† Oper. cit. Experiment 17 and 18.
‡ Oper. cit. Experiment 155–7–9 and 160.

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